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Appeal Brief
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UNITED STATES PATENT AND TRADEMARK OFFICE



APPELLANTS: Konstantine I. Iourcha, et al.

SERIAL NO.: 09/371,972

FILING DATE: August 10, 1999

TITLE: System and Method for Rasterizing Primitives Using Direct Interpolation

EXAMINER: Motilewa Good-Johnson

GROUP ART UNIT: 2672

ATTY.DKT.NO.: PA1774US

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## APPEAL BRIEF

Sir:

This is an Appeal from the rejection of claims 1-18 and 23-29. For the convenience of the Board of Appeals and Interferences a table of contents for the remainder of this Appeal Brief follows on the next page.

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## Table of Contents

## Real Party in Interest

The real party in interest in the above referenced patent application is S3 Graphics Co., Ltd. of the Grand Caymans, British West Indies. An assignment was recorded with the U.S. Patent and Trademark Office on October 29, 1999. This assignment, recorded at Reel 010341/Frame 0587, assigned the assignor's interest to S3 Inc. of Santa Clara, California. The patent assets were subsequently acquired by S3 Graphics Co., Ltd.

## Related Appeals and Interferences

To the present knowledge of the Appellant's representative, there are currently no other related appeals or interference proceedings to the present Appeal.

## Related Applications

To the present knowledge of Appellants' representative, there are no related applications to the present application.

## Status of the Claims

Claims 1-18 and 23-29 are pending and stand rejected. Claims 1-18 and 23-29 are rejected under 35 U.S.C. §102(e) as being anticipated by *Wood et al.* (U.S. Patent Number 6,204,856), hereinafter *Wood.* Claims 1-18 and 23-29 are further rejected under 35 U.S.C. §103(a) as being unpatentable over the book "Computer Graphics Principles and Practice" by Foley et al., herein after *Foley*, in view of *Shochet* (U.S. Patent Number 6,108,007).

## Status of Amendments Filed Subsequent to Final Rejection

No amendments have been filed subsequent to final rejection.

## A Summary of the Claimed Invention

The present invention provides a system and method for interpolating values in graphic primitives without requiring separate hardware for setup and rasterization stages. The present invention uses direct interpolation to generate a value for any point in a graphic primitive without necessarily traversing other portions of the primitive.

The method of the present invention is generalized so that any desired value at a given (random) point can be derived from know values at vertices. Given values of some known parameter at some position, such as a point intersecting a line that connects two vertices, the method of the present invention will determine, using direct perspective or linear interpolation, values for unknown parameters at that position. Advantageously, this technique allows for low setup overhead and higher primitive thoroughput since additional complex setup computations are not needed. Further, the technique facilitates computation on an as-needed basis and thus increases efficiency. Additionally, the present invention avoids needless calculation of areas not being drawn and facilitates processing for points on a random-access basis.

## Concise Statement of Issues

(1) Whether claims 1-18 and 23-29 are anticipated by *Wood.*; and

(2) Whether claims 1-18 and 23-29 are obvious over *Foley* in view of *Shochet.*

## Claim Groupings

Claims 1-18 and 23-29 are grouped together as being anticipated by *Wood*.

Claims 1-18 and 23-29 are grouped together as being unpatentable over *Foley* in view of *Shochet*.

The following chart is provided as a representation of the claims groups.

| Group | Claims | | Claim Types | Basis for Rejection |
|---|---|---|---|---|
| | Indep. | Dep. | | |
| I. Claims 1-18 and 23-29 | 1, 8, 9, 13-15, 23, 27 | 2-7, 28, 29 (from 1) 10-12, 16-18 (from 9) 24-26 (from 23) | System, Method, | 35 U.S.C. §102(e) |
| II. Claims 1-18 and 23-29 | 1, 8, 9, 13-15, 23, 27 | 2-7, 28, 29 (from 1) 10-12, 16-18 (from 9) 24-26 (from 23) | System, Method | 35 U.S.C. §103(a) |

## Arguments

**(1) Whether claims 1-18 and 23-29 are anticipated by *Wood*.**

In paragraph 5 of the final office action, the Examiner rejected claims 1-18 and 23-29 as being anticipated by *Wood*. *Wood* discloses an image data processing apparatus and method that parameterizes each triangle with a respective two-dimensional coordinate system (see Abstract). Appellants respectfully traverse.

In order to properly establish a rejection under 35 U.S.C. §102(e), a reference must teach every element of the claimed invention either explicitly or impliedly. Claim 1 of the present invention recites, in part, "***randomly*** selecting an interior point within the graphic primitive", which is supported by the specification as filed (emphasis added). The Examiner cited *Wood* as anticipating this element of claim 1, stating, "Wood discloses determining parameter values for positions within a triangle, col. 2, lines 12-14." The Examiner further states in paragraph 8, in response to arguments, that it "is inherent that the (sic) if one selects a point without a pattern or unsystematically, the point chosen is chosen at random."

Appellants traverse Examiner's argument that *Wood* teaches the element of "*randomly* selecting an interior point." *Wood* determines "values at positions within the triangle" (column 2, lines 12-14), using "***incrementally interpolated*** attributes for each triangle" (column 5, lines 53-55). *Wood* explains that triangle parameters "can be incrementally interpolated to an adjacent pixel, from there to another adjacent pixel and so on" (column 6, lines 5-7), wherein "[i]ncremental interpolation uses one pixel steps in x and y" (column 6, lines 19-20). Because the method of *Wood* sequentially interpolates adjacent pixels, *Wood* does not explicitly or impliedly disclose the "randomly selecting an interior point" element in claim 1 of the present invention.

Further in describing the point depicted in Figure 1, *Wood* only "illustrates the parameterising in the view space plane of a triangle with a point inside the triangle having co-ordinates s and t" (col. 3, lines 39-41). Depicting a single point as lying within a triangle in a figure does not disclose or suggest that the point must be identified by "randomly selecting" as required by claim 1, and does not teach that the point can or should be chosen at random. There is no discussion or suggestion in *Wood*, explicitly or implicitly disclosing the "randomly selecting an interior point" element of claim 1 of the present invention.

Additionally, claim 1 of the present invention recites in part, "receiving a signal from an interface, the signal comprising data about a plurality of vertices of the primitive and ***an independent variable***" (emphasis added). The Examiner cites *Wood* as anticipating this element of claim 1, stating "Wood discloses input to receive attribute data of the vertices, col. 5, lines 32-35." However, the cited passage from *Wood* merely states, "the main attribute processor 10 having an input to receive data in the form of an indexed face set of triangular polygons making up an image, with the main ***attributes comprising 3D (view-space) coordinates for the triangle vertices***" (emphasis added). *Wood* receives data about triangle vertices, but does not disclose an independent variable. There is no discussion anywhere in *Wood* regarding receiving data about an independent variable. Because this limitation of the claimed invention is not present, Appellants maintain that *Wood* does not anticipate claim 1 of the present invention.

Claim 1 further recites in part, "determining a channel value for each of the plurality of vertices of the primitive using the data about the plurality of vertices and ***the independent variable***" (emphasis added). The Examiner cited *Wood* as anticipating this element of claim 1, stating "Wood discloses determining a parameter value of a position within a triangle from the attribute value at each vertex, col. 2, lines 6-19." In a pertinent part of this passage, *Wood*

merely discloses "the determined parameter values at positions within the triangle determine contributions from the stored values for one or more attributes at each vertex, to give attribute values at each pixel." *Wood* discloses determining values based upon values at triangle vertices, but does not disclose an independent variable, as discussed above. Because the independent variable is not disclosed by *Wood*, *Wood* cannot determine "a channel value ... using data about the plurality of vertices and the independent variable." Appellants maintain that *Wood* does not disclose this element of claim 1.

Independent claims 8-9, 13-15, 23, and 27 are rejected on similar rationale as claim 1, and should similarly be allowed. These claims each include the limitation of "randomly" selecting an interior point, and claims 8-9, 13, 23, and 27 have the limitation of an independent variable. Because these independent claims recite at least one limitation that is not taught or suggested by *Wood*, these claims are not anticipated thereby and should be allowed.

Dependent claims 2-7 and 28-29, which depend directly from claim 1 and inherit all the limitations thereof, are patentable over *Wood* for at least the reasons advanced above in connection with claim 1. Dependent claims 10-12 and 16-18, which depend directly or indirectly from claim 9, and dependent claims 24-26, which depend directly from claim 23, are similarly patentable over *Wood* for at least the reasons advanced above in connection with claim 1.

**(2) Whether claims 1-18 and 23-29 are obvious over *Foley* in view of *Shochet*.**

In paragraph 7 of the final office action, the Examiner rejected claims 1-18 and 23-29 under 35 U.S.C. §103(a) as being unpatentable over *Foley*, in view of *Shochet*. Specifically, the Examiner states that "Foley discloses and (sic) equation that selects a random point, Ip and draws a horizontal line...to determine the value of the randomly selected interior point Ip, see figure 16.19." The Examiner further notes that *Foley* "fails to disclose receiving a signal from an interface with channel values or parameter data", but contended that *Shochet* discloses "data comprising an image sample" and "further discloses an interpolator unit and determining an interpolated pixel value." The Examiner concludes that it "would have been obvious to one of ordinary skill in the art at the time of the invention of Foley to include means for receiving the three-dimensional graphics data through the interface of Shochet because it is necessary to include input data for graphics processing." Appellants respectfully traverse.

Claim 1 discloses "***randomly*** selecting an interior point within the graphic primitive" which is supported by the specification as filed (emphasis added). Appellants submit that *Foley, Shochet*, or the combination of the two references does not disclose *randomly* selecting an interior point within the graphic primitive at which to determine an interpolated channel value. Thus, all claim limitations are not taught as required by MPEP §706.02(j). Further, the combination of receiving a signal from an interface and *randomly* selecting an interior point within the graphic primitive are neither suggested, taught, nor motivated by the cited references.

The Examiner cited *Foley* Figure 16.19 as having a "randomly selected interior point Ip," and by "indicating an equation, in which input values are used to determine the output of a selected point, this allows the invention of Foley to used (sic) randomly selected points to plug into the equation." On the contrary, *Foley* teaches sequentially processing scan lines, and

interpolating across scan lines in sequential order, stating, "[w]ith each edge, we store...for ***each unit change*** in y. A visible *span* on a scan line is filled in by interpolating..." (*Foley,* at 737, emphasis added). *Foley* specifies a requirement of line-by-line traversal in sequential or sequentially-related order to fill in a span across a line, rather than determining channel values for any ***randomly*** selected *point*. Inherently, this sequential traversal in *Foley* does not allow for a random selection of an interior point or the use of a randomly selected point. As *Foley* specifically recites this sequential interpolation limitation, Appellants submit that *Foley* fails to teach, motivate, or suggest the claimed invention.

Further, the combination of receiving a signal from an interface and *randomly* selecting an interior point within the graphic primitive are neither suggested, taught, nor motivated by the cited references. The Examiner notes that *Foley* "fails to disclose receiving a signal from an interface with channel values or parameter data", but contends that *Shochet* discloses "data comprising an image sample" and "further discloses an interpolator unit and determining an interpolated pixel value." However, *Shochet* is directed to "increasing interpolation bit precision using multi-channel texture mapping...provided in limited-precision graphics hardware" (*Shochet* abstract), wherein, "[i]n most sampling operations, first and second pixels 200 and 201 are ***adjacent pixels***..." (column 4, lines 31-33). The interpolation unit in *Shochet* merely manipulates data values of adjacent pixels in order to synthesize higher bit precision using lower precision equipment. There is no disclosure in *Shochet* of receiving a signal from an interface and *randomly* selecting an interior point of a graphic primitive as in claim 1 of the present invention.

The Examiner further concludes that it "would have been obvious to one of ordinary skill in the art at the time of the invention of Foley to include means for receiving the three-

dimensional graphics data through the interface of Shochet because it is necessary to include input data for graphics processing." On the contrary, even if *Foley* and *Shochet* were combined, the combination would not equal the present invention. As discussed, *Foley* discloses only sequential interpolation, and *Shochet* teaches only sequential interpolation by manipulating data from successive pixels. Neither *Foley* nor *Shochet,* nor the combination of the two references, suggests the "randomly selecting an interior point" limitation of claim 1 of the present invention. Thus, it would not have been obvious to one skilled in the art to combine these references, nor is there any suggestion or motivation to do so in order to obtain the present invention. The present invention permits random access to any point within a graphic primitive, in opposition to the methods of *Foley* and *Shochet,* which require burdensome sequential scan line-by-scan line traversal.

Appellants submit that both *Foley* and *Shochet* fail to teach, motivate, or suggest the claimed invention. Appellants submit that claim 1 is nonobvious in light of the cited references and is in condition for allowance. Independent claims 8, 9, 13-15, 23, and 27 are rejected upon similar rationale as claim 1, and should therefore be allowed for the reasons shown in claim 1 above.

If an independent claim is nonobvious under 35 U.S.C. 103, then any claim depending therefrom is nonobvious. *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988). Therefore, claims 2-7, and 28 and 29, dependent upon claim 1, are nonobvious. Similarly, claims 10-12 and 16, which depend upon claim 9; claim 17, which depends on claim 10; claim 18, which depends on claim 11; and claims 24-26, which depend upon claim 23, should also be allowed as nonobvious under *In re Fine*.

## Summary and Conclusions

In summary, Appellants contend that claims 1-18 and 23-29 are patentable and the rejection of those claims should be withdrawn and the claims allowed. With respect to claims 1, 8-9, 13-15, 23, and 27, Appellants contend that *Wood* does not teach or suggest randomly selecting an interior point within the graphic primitive, as required in these claims. Furthermore with respect to claims 1, 8-9, 13, 23, and 27, Appellants contend that *Wood* does not teach or suggest having an independent variable. As such, independent claims 1, 8-9, 13-15, 23, and 27 are not anticipated by *Wood.*

Similarly, independent claims 1, 8-9, 13-15, 23, and 27 are not obvious over *Foley* in view of *Shochet.* Neither *Foley* nor *Shochet*, individually or in combination, teach or suggest the claimed invention of randomly selecting an interior point within the graphic primitive. Additionally, there is no motivation or suggestion to combine these two references. For these reasons, independent claims 1, 8-9, 13-15, 23, and 27 are patentably distinguishable over the teachings of *Foley* in view of *Shochet.*

Further, as dependent claims 2-7, 10-12, 16-18, 24-26, and 28-29 depend from independent claims 1, 9, and 23, these dependent claims are allowable for the same reasons as discussed above in relations to the independent claims for which they depend. Therefore, the claims on appeal are allowable and the Appellants request that the rejection of claims 2-7, 10-12, 16-18, 24-26, and 28-29 be reversed, enabling this case to be allowed and passed to issue.

In conclusion, Appellants submit that for reasons stated and discussed above, the rejection of claims 1-18 and 23-29 under 35 U.S.C. §102 (e) and 35 U.S.C. §103(a) should be withdrawn.

Respectfully Submitted,

Konstantine I. Iourcha.

Date: 3/5/04 By: Susan Yee

Susan Yee, Reg. No. 41,388
Carr & Ferrell *LLP*
2200 Geng Road
Palo Alto, CA 94303
Phone (650) 812-3400
Fax (650) 812-3444

## Appendix

The claims on appeal are:

1. In a graphics system, a computer-implemented method of rendering a graphic primitive, the graphic primitive having a plurality of sides that define the edge of the primitive, the method comprising:

receiving a signal from an interface, the signal comprising data about a plurality of vertices of the primitive and an independent variable;

determining a channel value for each of the plurality of vertices of the primitive using the data about the plurality of vertices and the independent variable;

randomly selecting an interior point within the graphic primitive;

selecting at least two side points located on a side of the graphic primitive;

determining an interpolated channel value with an interpolation engine for each of the at least two side points; and

determining a channel value at the randomly selected interior point by interpolation from the interpolated channel values of each of the at least two side points.

2 The method of claim 1, wherein:

determining the interpolated channel value for each of the at least two side points further comprises performing linear interpolation using an interpolation engine to determine the interpolated channel values of the two points.

3. The method of claim 1, wherein:

determining the interpolated channel value for each of the at least two side points further comprises performing perspective interpolation using an interpolation engine to determine the interpolated channel values of the two points.

4. The method of claim 1, further comprising:

repeating each of the steps in claim 1 for a plurality of points in the graphic primitive.

5. The method of claim 1, wherein the channel value represents color.

6. The method of claim 1, wherein the channel value represents luminance.

7. The method of claim 1, wherein the channel value represents a texture coordinate.

8. An electronically-readable medium storing a program for permitting a computer to perform a method comprising:

receiving a signal from an interface, the signal comprising data about a plurality of vertices of the primitive and an independent variable;

determining a channel value for each of the plurality of vertices of the primitive using the data about the plurality of vertices and the independent variable;

randomly selecting an interior point within the graphic primitive;

determining an interpolated channel value with an interpolation engine for each of at least two side points; and

determining a channel value at the randomly selected interior point by interpolation from the interpolated channel values of each of the at least two side points.

9. A method of rendering a graphic primitive, the primitive including a plurality of edges, the method comprising:

receiving a signal from an interface, the signal comprising data about the plurality of vertices of the primitive and an independent variable;

deriving a channel value of a first point on a first edge of the graphic primitive using data about the plurality of vertices of the primitive and an independent variable;

deriving a channel value of a second point on a second edge of the graphic primitive using data about the plurality of vertices of the primitive and an independent variable; and

based upon the channel values of the first point and the second point, determining a channel value for a randomly selected interior point located within an interior surrounded by the edges of the graphic primitive.

10. The method of claim 9 wherein the step of determining the channel value of the first point. comprises:

determining the channel values of end points of the first edge to determine the channel value of the first point.

11. The method of claim 9 wherein the step of determining the channel value of the second point comprises:

determining the channel values of end points of the second edge to determine the channel value of the second point.

12. The method of claim 9 further comprising:

using depth values of the first point and second point to determine a channel value for the interior point.

13. An electronically-readable medium storing a program for permitting a computer to perform a method comprising:

receiving a signal from an interface, the signal comprising data about a plurality of vertices of a primitive and an independent variable;

deriving a channel value of a first point on a first edge of the graphic primitive using data about the plurality of vertices of the primitive and an independent variable;

deriving a channel value of a second point on a second edge of the graphic primitive using data about the plurality of vertices of the primitive and an independent variable; and

based upon the channel values of the first point and the second point, determining a channel value for a randomly selected interior point located within an interior surrounded by the edges of the graphic primitive.

14. A system for rendering a graphic primitive, the graphic primitive including a plurality of vertices and edges, the system comprising:

a plurality of agents configured to receive information from an interface related to the plurality of vertices, a randomly selected point, and generate output signals;

an arbiter coupled to the plurality of agents and configured to receive the output signals and to generate request signals;

an interpolation engine configured to receive the request signals and generate an output ratio signal dependent on at least some of the output signals from the plurality of agents; and

a router coupled to the interpolation engine and configured to transmit the output ratio signal to an input of at least one of the plurality of agents.

15. A system for rendering a graphic primitive in a graphics system, the graphic primitive having a plurality of sides, the system comprising:

a channel value input device configured to determine a channel value for each of a plurality of vertices of the graphic primitive using data received from an interface;

a point specifier, coupled to the channel value input device, configured to randomly select a point within the graphic primitive; and

an interpolation engine coupled to the point specifier and to the channel value input device, configured to determine an interpolated channel value for each of at least two side points using data received from the interface, and further configured to determine a channel value at the randomly selected point by interpolation from the interpolated values.

16. The method of claim 9 wherein the channel value of the interior point is further dependent upon a distance E between the interior point and the first point, and dependent upon a distance F between the interior point and the second point.

17. The method of claim 10 wherein the channel value of the first point is further dependent upon a distance A between the first point and the first end point of the first edge, and dependent upon a distance B between the first point and the second end point of the first edge.

18. The method of claim 11 wherein the channel value of the second point is further dependent upon a distance C between the second point and the first end point of the second edge, and dependent upon a distance D between the second point and the second end point of the second edge.

23. A method of generating interpolated values for use in rendering a graphic primitive, the method comprising:

receiving from an interface an independent variable X representing the physical portion of a randomly selected point;

receiving vertex values $X_0$, $X_1$ of a primitive edge having the randomly selected point with the physical position represented by the independent variable X;

receiving depth values $Z_0$, $Z_1$ associated with the vertex values $X_0$, $X_1$; and

calculating a ratio value dependent upon the independent variable X, vertex values $X_0$, $X_1$, and depth values $Z_0$, $Z_1$.

24. The method of claim 23 further comprising:

receiving color values associated with the vertex values $X_0$, $X_1$; and

calculating interpolated color values for the point based upon the ratio value and the color values associated with the vertex values of $X_0$, $X_1$.

25. The method of claim 23 further comprising:

receiving texture values associated with the vertex values $X_0$, $X_1$; and

calculating interpolated texture values for the point based upon the ratio value and the texture values associated with the vertex values $X_0$, $X_1$.

26. The method of claim 23 further comprising:

calculating a screen-based Z coordinate for the point based upon the independent variable X, vertex values $X_0$, $X_1$, and depth values $Z_0$, $Z_1$.

27. An electronically-readable medium storing a program for permitting a computer to perform a method of generating interpolated values for use in rendering a graphic primitive, the method comprising:

receiving from an interface an independent variable X representing the physical portion of a randomly selected point;

receiving from the interface vertex values $X_0$, $X_1$ of a primitive edge having the randomly selected point with the physical position represented by the independent variable X;

receiving from the interface depth values $Z_0$, $Z_1$ associated the vertex values of $X_0$, $X_1$; and

calculating a ratio value dependent upon the independent variable X, vertex values $X_0$, $X_1$, and depth values $Z_0$, $Z_1$.

28. The method of claim 1, wherein:

determining a channel value further comprises performing linear interpolation using an interpolation engine to determine the channel value of the selected interior point within the graphic primitive.

29. The method of claim 1, wherein:

determining the channel value further comprises performing perspective interpolation using an interpolation engine to determine the channel value of the selected interior point.